# "ANTI-REVERSION APPARATUS"

## FIELD OF THE INVENTION

The present invention relates to apparatus for affecting reversionary flow characteristics in an internal combustion engine. More particularly, a device is located in the intake or exhaust of an engine for influencing gas and sound waves for improving engine performance.

## BACKGROUND OF THE INVENTION

Intake and exhaust gas flow in an internal combustion engine is a complex combination of pulsing high pressure and low pressure gas flows and sound waves related to the cyclical action of pistons and the intake and exhaust valves of the internal combustion engine. The interaction of the various flows can affect engine efficiency.

The gases are routed through intake and exhaust systems primarily comprising a tubular conduit arranged to feed gases to the engine (intake) and extract gases from the engine (exhaust). Performance is related in part to the size of the conduit and the characteristics of the flow therethrough. As stated, the gas flow includes longitudinally propagated sound waves which can aid or interfere with gas flow. Through interaction of the gas flow and sound waves it is possible to suffer a reverse gas flow with an associated reduction in engine performance.

A variety of techniques have been proffered to suppress sound while maximizing engine efficiency. It is known to design anti-reversing exhaust systems which attempt to cancel reverse wave propagation. Factors include the size and number of conduits, devices inserted therein and relative lengths, sizes and arrangements of components associated therewith.

## SUMMARY OF THE INVENTION

An anti-reversionary device is provided for positioning in the intake or the exhaust conduit of an internal combustion, preferably substantially adjacent the cylinder head of the engine.

In one aspect, the anti-reversionary device is adapted to a conduit having gas flow therethrough comprising: an inner pipe is positioned substantially concentrically within the conduit; and an annular wall extending between the pipe and the conduit, the inner pipe having a tubular gas inlet projecting upstream from the annular wall for separating the gas flow into a annular gas flow and a central gas flow, the central gas flow being faster than the annular gas flow at the tubular gas inlet, the annular wall having a plurality of ports formed therein and about the inner pipe, the ports forming passages directed radially inward and downstream for accelerating the annular gas flow for discharge into the central gas flow.

In another embodiment, the annular wall itself is angled downstream from the inner pipe to the conduit. In another embodiment, the inner pipe is

suspended in a tubular housing by the annular wall, the tubular housing being adapted to fit into the conduit.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a partial cross-sectional view of a gas flow conduit with a perspective view of an anti-reversionary device of one embodiment of the invention fit therein;

Figure 2 is a cross-sectional end view of the conduit and anti-reversionary device according to Fig. 1, viewed from the upstream side of the device;

Figure 3 is a partial section, cross-sectional view of one embodiment of the device of Fig. 1 detailing the inner pipe, one of a plurality of annular wall ports and the gas flow therethrough;

Figure 4 is a cross sectional view of a plurality of devices fit into a conduit;

Figures 5a – 5c illustrate computer-generated flow simulations with and without an anti-reversionary device of the present invention, more particularly,

Fig. 5a depicts the prior art conventional case of the flow velocity of gas in a conduit without the device;

Fig. 5b illustrated a form of anti-reversionary device which is modeled in Fig. 5c; and

Fig. 5c depicts the flow velocity of gas with the device of Fig. 5b.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The anti-reversionary device of the current invention is adaptable to either intake or exhaust system of an engine, both of which are subject to the pulsating gas flow and sound waves inherent in a valved, internal combustion engine. Herein, and as set forth in the examples below, the device is been described in the context of application to an exhaust system.

The intake, combustion and exhaust cycles of an internal combustion engine produce pulsating gas flows. In the exhaust gas flow, the products of combustion are typically expelled at about 300-800 feet per minute. Sound waves of the combustion process can travel at a nominal 1500 - 1800 feet per second. The faster sound waves can form a partial vacuum zone into which the slower gas flow can be drawn, resulting in reversion. As known, reversion is detrimental to engine performance.

As known to those skilled in the art, flow through a conduit, including flow through an exhaust pipe, is typified by a faster flow in a center flow stream and slower flow along the conduit wall; the boundary layer flow. As shown in Fig. 5a, the velocity adjacent the wall is slower than the velocity at the center, according to the well known velocity provided in a pipe. The characteristics of pipe flow are used to advantage in the present invention.

Turning to Figs. 1 and 3, one embodiment of an anti-reversionary device 10 for installation into the bore 11 of a conduit 12 comprising an inner pipe 13 supported substantially concentrically in the bore 11 is shown. The conduit 12 is

connected to an internal combustion engine (not shown). Gas flow adjacent the center of the conduit 12 passes though the inner pipe 13. An annular wall 14 extends between the conduit 12 and the inner pipe 13. The inner pipe 13 has a tubular inlet 15 which extends upstream of the annular wall 14 for separating the gas flow 13 into a slower annular flow 16 adjacent the conduit 12 and a faster gas flow 17 more central to the conduit.

In some embodiments, the annular wall 14 may be affixed directly to the conduit 12. In other embodiments as shown in Fig. 3, the annular wall 14 may be integral with a cylindrical housing 18 forming a unitary body or device 10, the housing 18 being sized to fit the bore 11 of the conduit 12. Such as device is readily formed of sheet materials such as those having a substantially uniform wall thickness.

Further, the annular wall 14 may be angled, forming a truncated cone. As shown in Fig. 1, One embodiment finds the annular wall angled downstream and radially outwardly from the inner pipe 13 to the conduit 12.

With reference to Figs. 1 – 3, a plurality of ports 20 are formed in the annular wall 14 for the admitting slower gas flow 16 adjacent the conduit 12 upstream of the device 10 and directed discharge through passages 21 (best seen in Fig. 3) through the annular wall 14 to the conduit 12 downstream of the device 10.

The total cross sectional area of the passages 21 is somewhat less than the cross sectional area of the annular wall 14. One approach is to maximize

the cross-sectional area of the passages 21 within the capability of conventional manufacturing techniques for the material of the wall 14. Slower annular gas flow 16 is accelerated through the passages 21 to rejoin the faster central gas 17 downstream of the device 10. Where the annular wall 14 has some thickness, the passages 21 can be angled somewhat to direct the annular gas flow 16 radially inwardly to the faster central flow 17.

As shown in Fig. 3, the ports 20 form passages 21 which are angled through the annular wall 14. In one embodiment, the passages 21 are angled at about 20 – 30 degrees relative to the conduit 12, and parallel to a conduit axis A. Ports, can be spaced at equi-distance circumferentially along the 360 degrees about the annular wall. Twenty-four circular ports 20 could be spaced at 15 degrees apart with a port diameter commensurate to having some supporting annular wall 14 remaining between adjacent ports 20. In another embodiment, twenty-four ports 20 could be spaced at about 14.3 degree increments and a twenty-fifth port 10 at 17 degrees; there not being a fixed requirement for specific spacing of ports.

As shown in Fig. 4, one or more of the anti-reversionary devices 10 can be installed in a conduit 12.

Example

For a conventional 2 inch outside diameter (OD) exhaust conduit 12 having a 1.88 inch inside diameter (ID) in the bore 11, an anti-reversionary device

10 can be manufactured having a 1.5 OD tubular intake and a 1.37 inch ID. A housing 18 is sized with a 1.88 inch OD to fit the bore 11. The tubular inlet 15, inner pipe 13, annular wall 14 and housing 18 typically have a 1/16 inch wall thickness. The inner pipe 13 can extend about 0.43 inches upstream of the annular wall 14. The dimensions in the present example create a clearance about the inner pipe 13; here being 0.25 inches measured between the respective ID's of the conduit 12 and the inner pipe. This clearance affects the slower annular boundary layer flow 16 adjacent the conduit 12 for directed discharge into the faster central flow 17.

The annular wall is angled at about 45 degrees. Twenty-five ports 20, each about 0.125 inches in diameter are formed in the annular wall 14. Passages 21 are formed from each port 20 and through the annular wall 14. In this example, the passages 21 are angled through the annular wall 14 at about 26 degrees.

Turning to Figs. 5a-5c, one can see the effect on the velocity of the exhaust gas flow. In Fig. 5a, a computer simulation of the conventional pipe flow in a conduit 12 is illustrated, having the slower boundary layer flow 16 adjacent the conduit 12 and faster-and-faster flow as one approaches the center axis A. The simulation work was performed on software entitled <u>Ideal Flow Machine And Mapper</u> developed by as provided by Virginia Tech, Department of Aerospace and Ocean Engineering, Blacksburg VA, USA and available at http://www.aoe.vt.edu/~devenpor/aoe5104/ifm/ifminfo.html.

An anti-reversion device 10 of the present invention and as shown in Fig. 5b, was installed into the conduit 12. Once installed, a second computer

simulation was performed, as illustrated in Fig. 5c. which demonstrates an increase in velocity of the slower annular or boundary layer flow 16 to approach the faster central gas flow 17. The acceleration of the slower annular flow 16 was achieved with little or no backpressure, typical of a standard venturi principle, and with a suppression of the environment which causes reversion.

Similar results can be obtained using scaled dimensions for those demonstrated above.